The re-analysis of ozone profile data from a 41-year series of SBUV instruments.

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In this study we present the validation of ozone profiles from a number of Solar Back Scattered Ultra Violet (SBUV) and SBUV/2 instruments that were recently reprocessed using an updated (Version 8.6) algorithm. The SBUV dataset provides the longest available record of global ozone profiles, spanning a 41-year period from 1970 to 2011 (except a 5-year gap in the 1970s) and includes ozone profile records obtained from the Nimbus-4 BUV and Nimbus-7 SBUV instruments, and a series of SBUV(/2) instruments launched on NOAA operational satellites (NOAA 09, 11, 14, 16, 17, 18, 19). Although modifications in instrument design were made in the evolution from the BUV instrument to the modern SBUV(/2) model, the basic principles of the measurement technique and retrieval algorithm remain the same. The long term SBUV data record allows us to create a consistent, calibrated dataset of ozone profiles that can be used for climate studies and trend analyses. In particular, we focus on estimating the various sources of error in the SBUV profile ozone retrievals using independent observations and analysis of the algorithm itself. For the first time we include in the metadata a quantitative estimate of the smoothing error, defined as the error due to profile variability that the SBUV observing system cannot inherently measure. The magnitude of the smoothing error varies with altitude, latitude, season and solar zenith angle. Between 10 and 1 hPa the smoothing errors for the SBUV monthly zonal mean retrievals are of the order of 1%, but start to increase above and below this layer. The largest smoothing errors, as large as 15-20%, were detected in in the troposphere. The SBUV averaging kernels, provided with the ozone profiles in version 8.6, help to eliminate the smoothing effect when comparing the SBUV profiles with high vertical resolution measurements, and make it convenient to use the SBUV ozone profiles for data assimilation and model validation purposes. The smoothing error can also be minimized by combining layers of data, and we will discuss recommendations for this approach as well.

The SBUV ozone profiles have been intensively validated against satellite profile measurements obtained from the Microwave Limb Sounders (MLS) (on board the UARS and AURA satellites), Stratospheric Aerosol and Gas Experiment (SAGE) and Michelson Interferometer for Passive Atmospheric Sounding (MIPAS). Also, we compare coincident and collocated SBUV ozone retrievals with observations made by ground-based instruments, such as microwave spectrometers, lidars, Umkehr instruments and balloon-borne ozonosondes. Finally, we compare the SBUV ozone profiles with output from the NASA GSFC GEOS-CCM model. In the stratosphere between 25 and 1 hPa the mean biases and standard deviations are within 5% for monthly mean ozone profiles. Above and below this layer the vertical resolution of the SBUV algorithm decreases and the effects of vertical smoothing should be taken into account. Though the SBUV algorithm has a coarser vertical resolution in the lower stratosphere and troposphere, it is capable of precisely estimating the integrated ozone column between the surface and 25 hPa. The time series of the tropospheric - lower stratospheric ozone column derived from SBUV agrees within 5% with the corresponding values observed by an ensemble of ozone sonde stations in North Hemisphere. Drift of the ozone time series obtained from each SBUV(/2) instrument relative to ground based and satellite measurements are evaluated and some features of individual SBUV(/2) instruments are discussed.

In addition to evaluating individual instruments against independent observations, we also focus on the instrument to instrument consistency in the series. Overall, Version 8.6 ozone profiles obtained from two different SBUV(/2) instruments compare within a couple of percent during overlap periods and are consistently varying in time, with some exceptions. Some of the noted discrepancies might be associated with ozone diurnal variations, since the difference in the local time of the observations for a pair of SBUV(/2) instruments could be several hours. Other issues include the potential short-term drift in measurements as the instrument orbit drifts, and measurements are obtained at high solar zenith angles (>85°). Based on the results of the validation, a consistent, calibrated dataset of SBUV ozone profiles has been created based on internal calibration only.

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